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CITY OF SANTA BARBARA
PLANNING DIVISION

UPDATED NOISE CONTROL ANALYSIS

FOR

MIXED COMMERCIAL AND RESIDENTIAL USE DEVELOPMENT

318 NORTH STATE STREET

SANTA BARBARA, CA

September 5, 2006

Prepared by

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EXHIBIT F

INTRODUCTION

The subject project is a 33 unit, approximately 48,100 square foot residential and approximately 35,600 square foot commercial mixed used development, located on the northeastern corner of Highway 101 and State Street in the City of Santa Barbara. In order to comply with City noise criteria 60 dB in outdoor living spaces and 45 dB in interior living spaces of the residential portions of the project, and to provide acoustic separation between uses in accordance with California noise insulation standards, the project developer has requested that an acoustical analysis be undertaken. This report includes the following:

- Results of on-site measurements of noise from Highway 101
- Results of FHWA Traffic Noise Model calculations of noise levels at outdoor living spaces on the project
- Assessment of requirements for noise reduction treatments in indoor and outdoor living areas
- Assessment of requirements for airborne and impact noise suppression between residential units and between residential and commercial uses

PROJCT CRITERIA

The City of Santa Barbara requires new residential developments to provide outdoor living spaces with noise exposure below L_{dn} 60 dB[1] and indoor living spaces with noise exposure below L_{dn} 45 dB.

The State of California Title 25 Noise Insulation Standards require new multi-family residences to provide the following:

- Noise levels in habitable rooms below CNEL[2] 45 dB with doors and windows closed. If windows must be closed to meet the criterion, alternative ventilation may be necessary.
- Walls and Floor/Ceilings separating residential units must be rated at STC 50 and IIC 50[3] (floors).

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[1] Note – L_{dn} (Day-Night Average Noise Level) is a 24 hour average noise level in which noises occurring between 10 p.m. and 7 a.m. are weighted by +10 dB. Sound levels are expressed in decibels (dB). Per international standard, sound levels are measured using the A-weighting frequency filter unless otherwise specified. The A-weighting filter approximates the response of human hearing at moderate levels by suppressing low and very high frequency sounds and slightly accentuating sounds in the 2 – 4 kHz range.

[2] CNEL (Community Noise Equivalent Level) is similar to Ldn with the addition of a +5 dB weighting for sounds occurring between 7 and 10 p.m.

[3] STC and IIC are single number ratings of partitions' capability to suppress airborne and impact noises. The 50 ratings are for laboratory tests. For tests conducted in the field, 45 ratings are accepted.

PROJECT SETTING AND OUTDOOR NOISE EXPOSURE

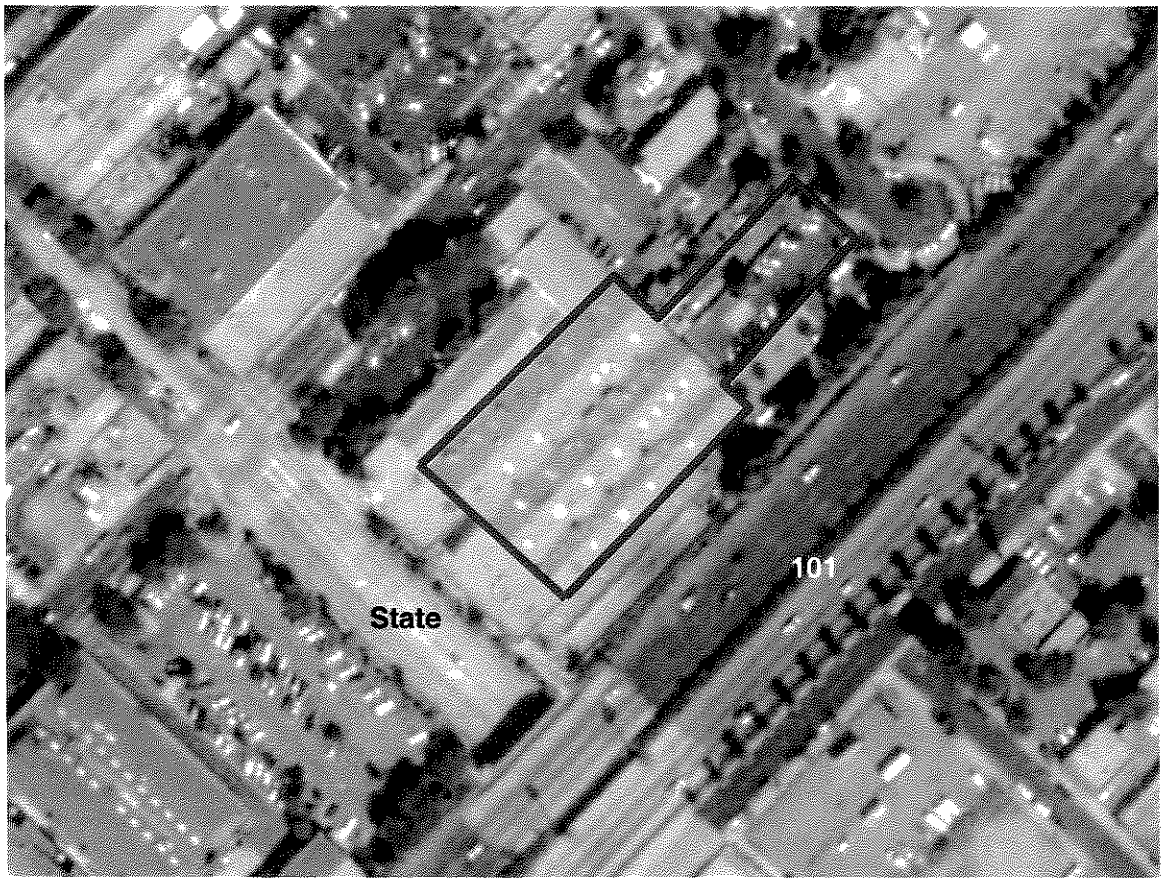

Figure 1. Aerial Photo of Project Area, Showing Existing Uses and Major Noise Sources

As shown on the aerial photo, Figure 1, the project is located on the east side of north State Street, set back approximately 57 ft from the northerly edge of Highway 101 and partially shielded from it by existing auto-repair facilities, to remain. The partial site plan in Figure 2 shows that the project extends 450 ft eastward from State Street to Anacapa Street.

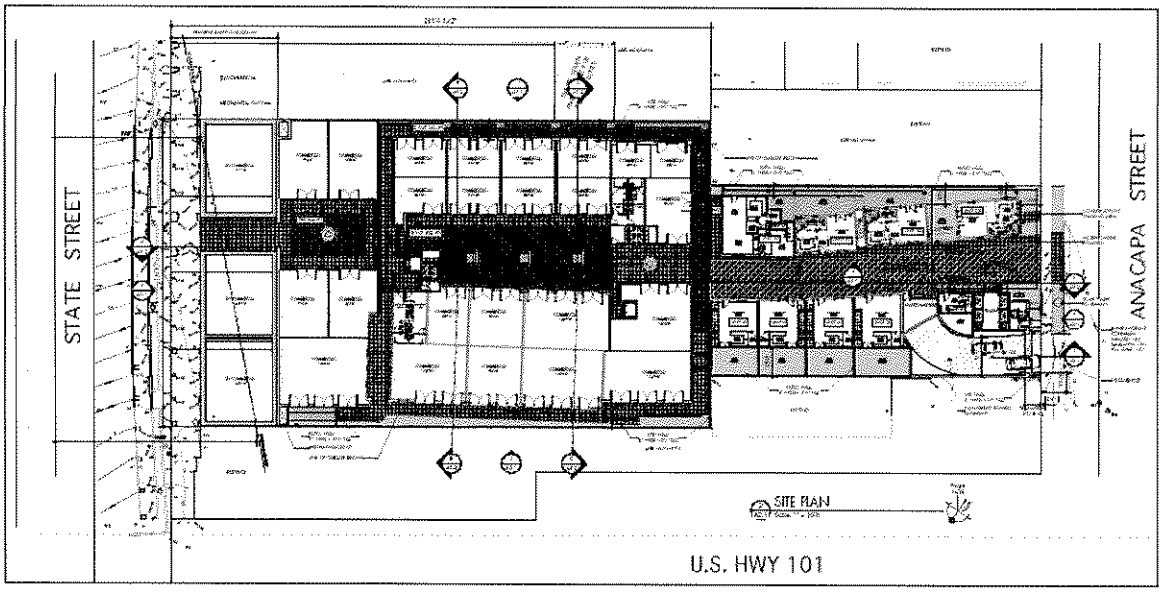

Figure 2. Revised First Floor / Site Plan Showing Roadways and Existing Intervening Structures

The primary source of noise affecting the project is Highway 101 traffic, with Caltrans data indicating between 100,000 and 120,000 ADT, or approximately 10,500 peak hourly. Secondary noise is from State Street. ATE traffic counts indicate peak hour off-season traffic at 881 VPH and peak hour summer Sunday traffic 1255 VPH. Occasional aircraft overflights and miscellaneous transient noises emanating from the existing auto shop facilities (see Figure 2).

Noise levels were assessed both by computer modeling using FHWA TNM 2.5 and by direct measurements. TNM 2.5 was used both because it is based on accepted vehicle noise emissions and propagation models and because it contains built-in methods for assessment of the effects of complex noise barriers. The outdoor living spaces on the project are situated so that they are shielded from the highways behind walls or entire building elements.

The direct measurements were used to check the overall levels computed by TNM 2.5 at unshielded locations and to obtain frequency spectrum data do aid in the determination of noise control treatments for indoor areas. Most measurements were taken near the extreme eastern end of the project near Anacapa Street, with the measurement microphone on an 18 ft high stand to avoid the shielding effect of nearby vegetation and structures. One measurement was taken with the microphone stand on the roof of the existing building, so that the microphone was over 30 ft above the ground to simulate exposure at the upper floors of the proposed project. Measurements covered various times of day ranging from early morning to mid-evening. A summary of the overall noise level measurements is shown in Figure 3. The heavy red line represents L_{eq}[4], the metric used for computation of L_{dn} and CNEL.. The other statistics demonstrate changes in the acoustical environment at different times of day. For example, the shorter-term statistics L5 and L1 (levels exceeded 5% and 1% of the measurement period) are governed by individual trucks and are relatively independent of time. The L99, L95 and L90 are governed by noise in the gaps between trucks and are seen to be quite low very early in

[4] L_{eq} – Equivalent sound level in dB, is the level of a continuous sound of the same duration as the measured sound that produces the same total acoustic energy.

the morning and highest during the morning "rush hour." The sharp peak at 8:45 a.m. is somewhat anomalous, resulting from a trash truck loading up in the parking lot near the measurement microphone.

From the final two measurements, it can be seen that the noise at high elevation and slightly closer to Highway 101 was 74 dB and about 4 dB higher than that measured at the partially shielded position a the east end of the site.

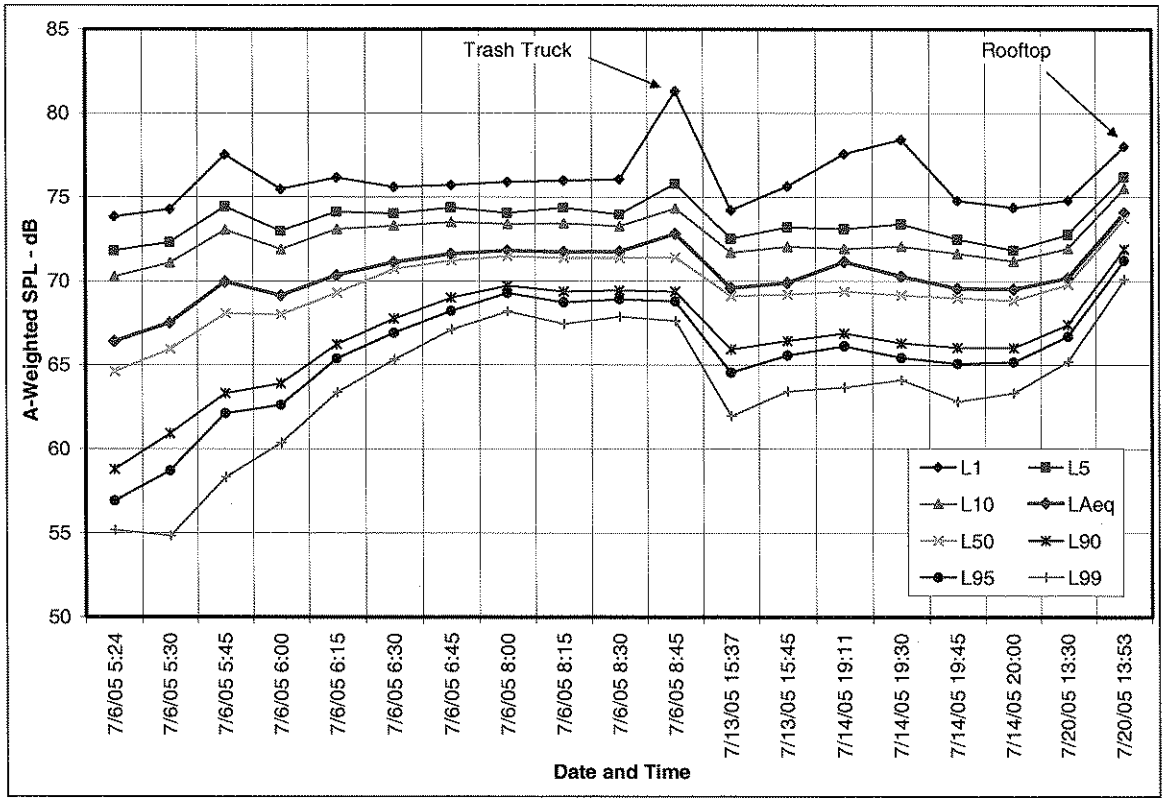

Figure 3. Noise Measurement Results from Southeast Corner of Site, 18 feet Above Ground

The overall result, combined with normal temporal distribution of traffic, results in CNEL 72-73 dB at the primary measurement position and 76 dB at the rooftop. Note that the City criterion for outdoor recreation areas is CNEL 60 dB, so 12-16 dB noise reduction will be required for outdoor spaces near the south side of the project.

The City criterion for indoor noise levels is CNEL 45 dB, requiring up to 31 dB reduction from the measured levels. From a comfort standpoint, it would be desirable to keep L5 below 45 dB to control individual truck noise. Therefore, a target noise reduction of 30-32 dB to indoor spaces is recommended.

Representative frequency spectra for morning rush hour and mid-evening "relaxation" time periods are shown in Figure 4. These spectra have been A-weighted to better illustrate the relative importance of the frequency ranges in contribution to the overall level. Here it can be seen that although truck exhaust noise is significant in the difficult to control 80-125 Hz range, the dominant noise is a broad band for 500 to 1600 Hz, and this is relatively well attenuated by stucco, insulation and drywall building construction. The principal issue will be providing windows with heavy enough glass and robust

enough frames and seals to match the rest of the construction. Further, any windows with direct exposure to the highway will have to be closed to meet the 45 dB criterion, so adequate ventilation systems will be required.

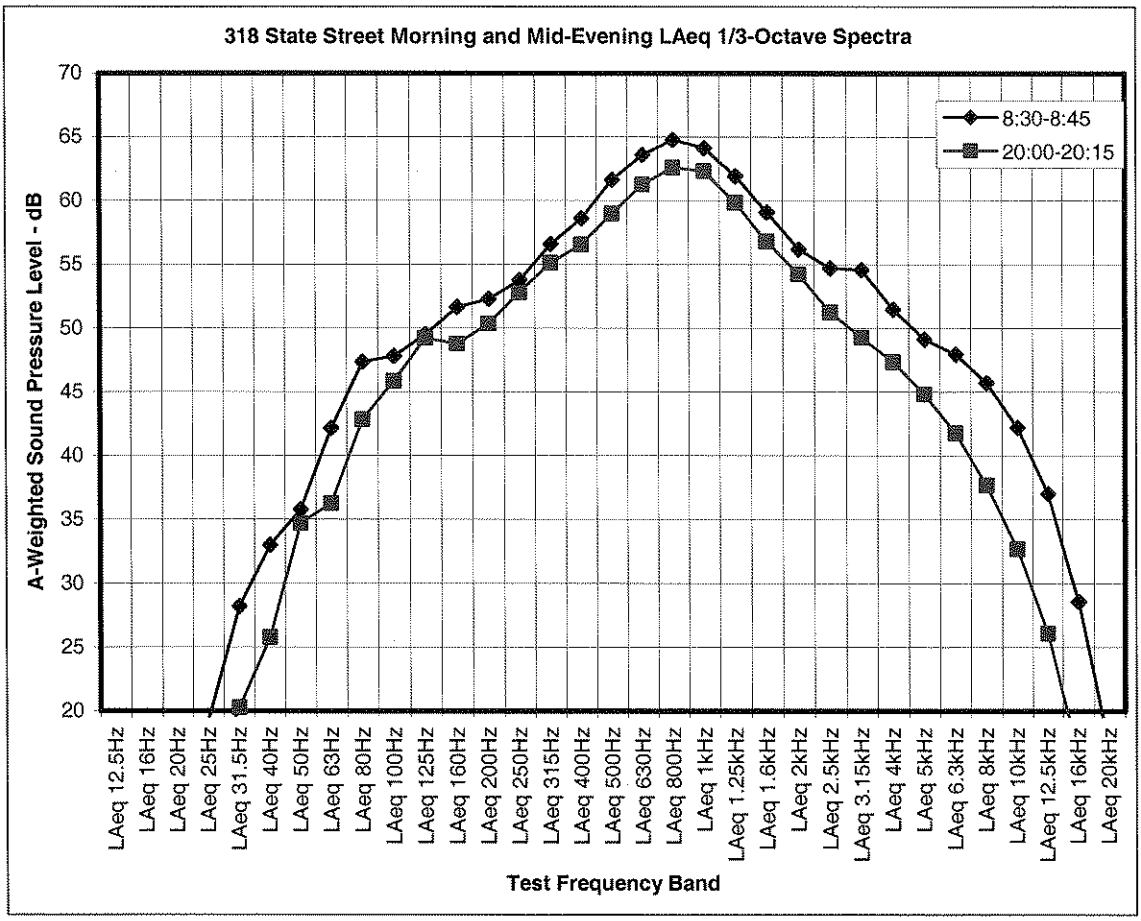

Figure 4. A-Weighted Frequency Spectrum of Measured Noise

Figure 3.

Figure 5 shows a plan view of the model evaluated by FHWY TNM 2.5. The red lines are representation of building faces that act as noise barriers. The small squares are reception points that represent either building face noise exposure points, outdoor living spaces of the individual units or on-site measurement positions.

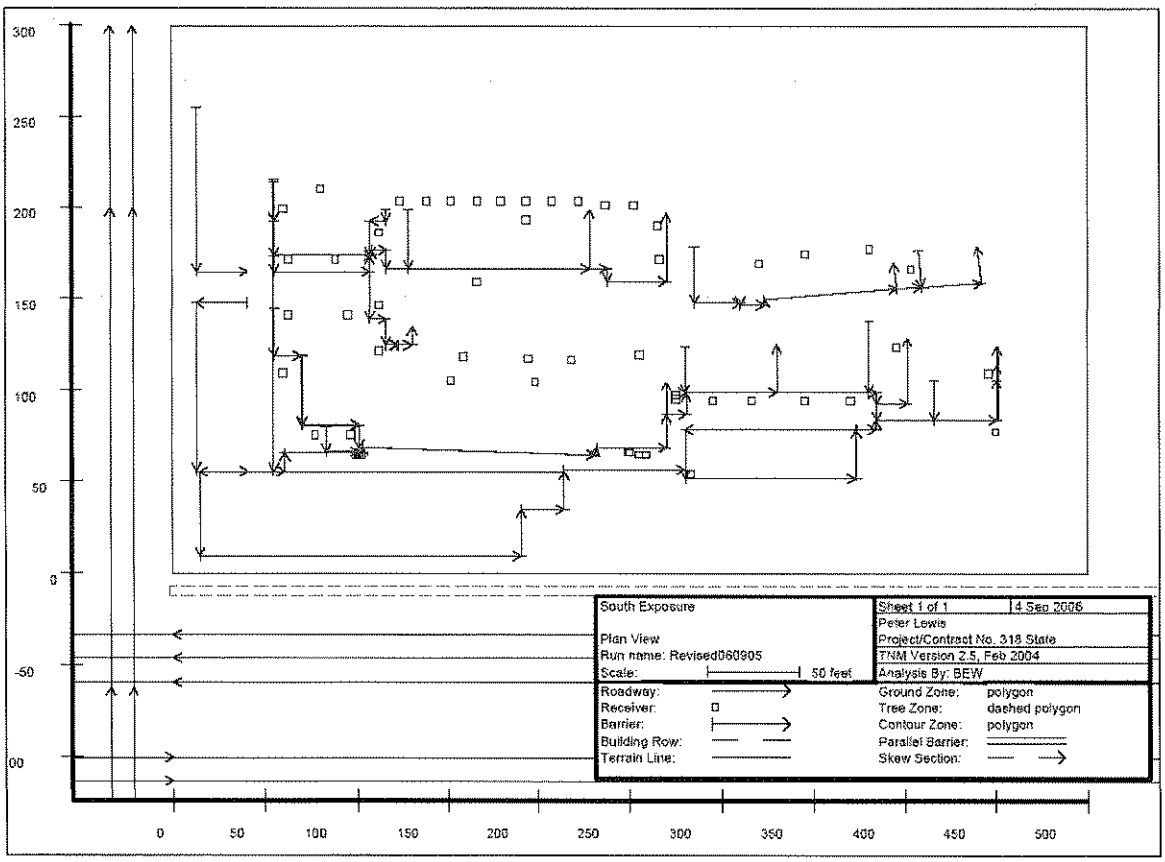

Figure 5. Project Model Evaluated by TNM 2.5

Results of the computations are shown in Table 1 below. Note that the calculated noise levels for the Microphone and Rooftop position are for the two positions at which direct measurements were taken. The computed levels at these positions are 3-5 dB higher than measured noise levels, indicating that TNM 2.5 provides conservative results.

Table 1. Summary of TNM 2.5 Calculation Results

Location	Easting	Northing	Ref. Elev.	Elev. re Ref.	DNL 2006	DNL 2016
Microphone"	450	78	0	18	77	78
Rooftop	283	55	0	30	77	78
Pool Deck"	255	120	26	3	57	58
Unit 1"	446	110	26	5	60	60
Unit 2"	395	124	26	5	56	57
Unit 3"	370	95	0	5	59	60
Unit 4"	345	95	0	5	57	57
Unit 5"	316	95	0	5	54	55
Unit 6"	295	95	0	5	53	54
Unit 7"	275	96	14	5	53	54
Unit 8"	218	117	14	5	56	56
Unit 9"	194	118	14	5	56	57
Unit 10"	158	119	14	5	56	56
Unit 11"	77	76	14	5	55	56

Location	Easting	Northing	Ref. Elev.	Elev. re Ref.	DNL 2006	DNL 2016
Unit 12"	112	122	14	5	55	56
Unit 13"	60	110	14	5	53	54
Unit 14"	80	211	14	5	51	52
Unit 15"	138	204	14	5	48	48
Unit 16"	166	204	14	5	48	48
Unit 17"	193	204	14	5	47	48
Unit 18"	222	204	14	5	47	48
Unit 19 E"	265	191	14	5	44	45
Unit 19 N"	252	202	14	5	45	45
Unit 20"	275	98	26	4	60	60
Unit 21"	198	105	26	5	59	60
Unit 22"	151	106	26	5	58	59
Unit 23"	96	76	26	4	60	60
Unit 24 E"	95	142	26	5	56	57
Unit 24 W"	63	142	26	5	58	59
Unit 25 N"	60	200	26	5	59	60
Unit 25 SE"	88	172	26	5	56	57
Unit 25 SW"	63	172	26	5	58	59
Unit 26 E"	151	204	26	5	49	50
Unit 26 W"	123	204	26	5	53	53
Unit 27 E"	207	204	26	5	49	50
Unit 27 W"	179	204	26	5	49	50
Unit 28 E"	266	172	26	5	46	47
Unit 28 N"	237	202	26	5	49	50
Unit 29 N"	193	194	38	5	53	54
Unit 29 NW"	112	187	38	5	58	59
Unit 29 SW"	112	147	38	5	60	60
Unit 30"	320	170	0	5	42	43
Unit 31"	345	175	0	5	45	45
Unit 32"	380	178	14	5	50	51
Unit 33"	403	167	14	5	52	53

Note in Table 1 that noise levels in required outdoor patios at all units are below 60 dB for both current and 10 year future conditions, computed at 1.6% annual growth in traffic flows and assuming vehicle noise emissions remain constant. TNM 2.5 computation for Unit 21's outdoor terrace showed 61.5 dB, or 1.5 dB above the City criterion. If allowance is taken for the TNM over-prediction demonstrated by measurements, the noise level in the outdoor living spaces are below 60 dB and in compliance with the City standard with a modest to considerable margin, depending upon location. In the model, patios on units with south, east or west exposure were modeled as having barriers that extended vertically to 2 ft above ear height to block line-of sight transmission of sound from Highway 101. Standard ear height is 60 inches for standing and 45 inches for seated.

INDOOR NOISE CONTROL

As shown in both the TNM 2.5 computations and the on-site noise measurements, noise levels at the south side of the project, particularly those at upper floors with reduced shielding by the existing structures, will be exposed to traffic noise in the 70+ dB range and require noise attenuating exterior shell construction to maintain noise below L_{dn}/CNEL 45 dB indoors.

Figures 6-10 on the next two pages show the unit plan layout of residences on the 1st through 4th floors and Roof as of March 30, 2006. The 1st Floor, shown in Figures 2 and 6, consists primarily of commercial uses. Table 2 shows TNM 2.5 computed noise levels at outdoor faces of residential units exposed to Highway 101. These are seen to range from below 60 dB to approximately[5] 77 dB depending upon shielding.

Table 2. Noise Exposures at South-Facing Residential Units

Unit	Floor 1 S	Floor 2 S	Floor 3 S	Floor 4 S	Floor 4 E
1		77.0	76.9		
2		77.0	76.9		
3	64.0	76.5			
4	52.5	76.5			
5	52.2	76.4	76.5		
6	50.2	76.3	76.3		
7		76.7			
8		75.0			
9		63.9			
10		61.9			
11		59.2			
12		58.6	76.6		
20			76.9		
21			76.9	77.0	62
22			76.6	77.1	
23			76.1	77.0	
24			75.7		

[5] Note that presentation of noise measurements and computations to 0.1 dB precision is for purposes of illustration and should not be construed as an indication of accuracy. Typical calibration tolerance for acoustic measurement equipment is ±0.3 dB and the minimum discernable difference in sound levels under field conditions is approximately ±1 dB. Differences of ±3 dB are generally considered to be clearly noticeable and ±10 dB corresponds approximately to doubling or halving of subjective loudness judgment.

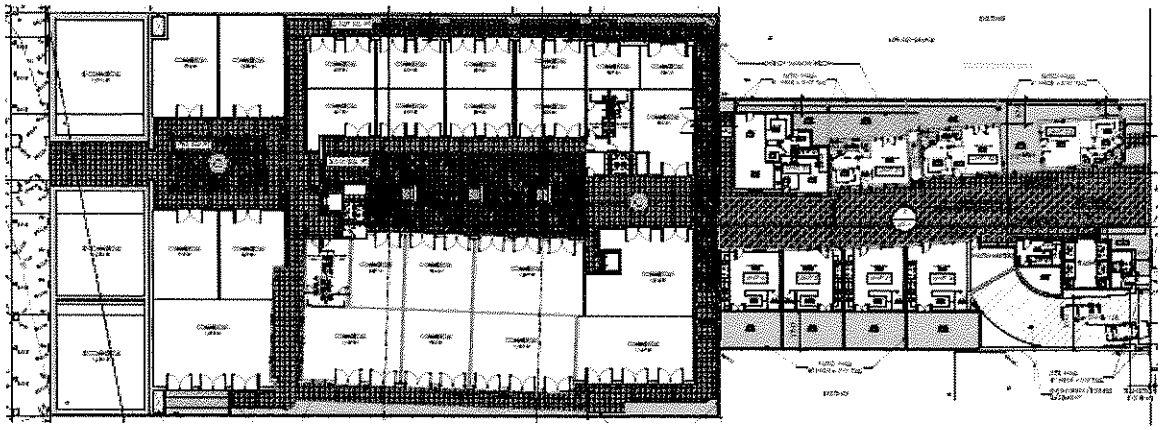

Figure 6. First Floor Unit Plan

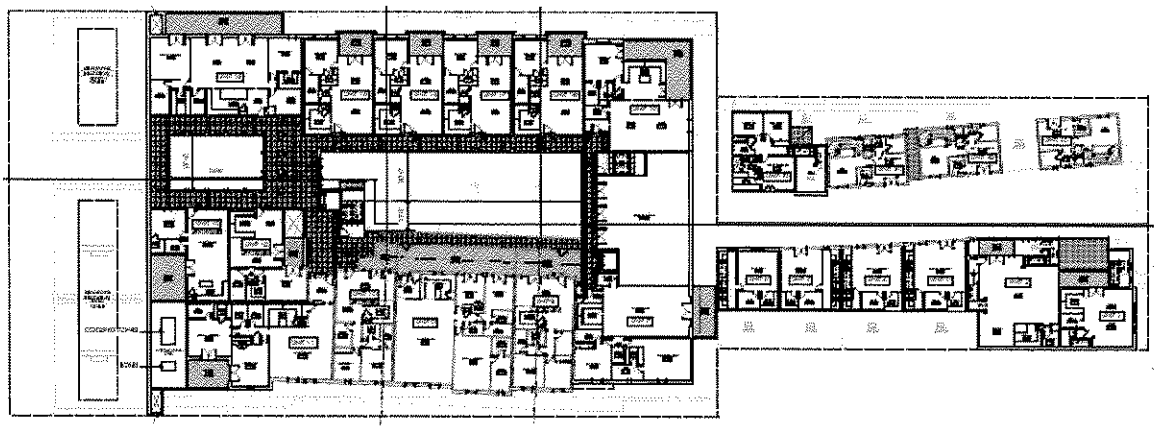

Figure 7. Second Floor Unit Plan

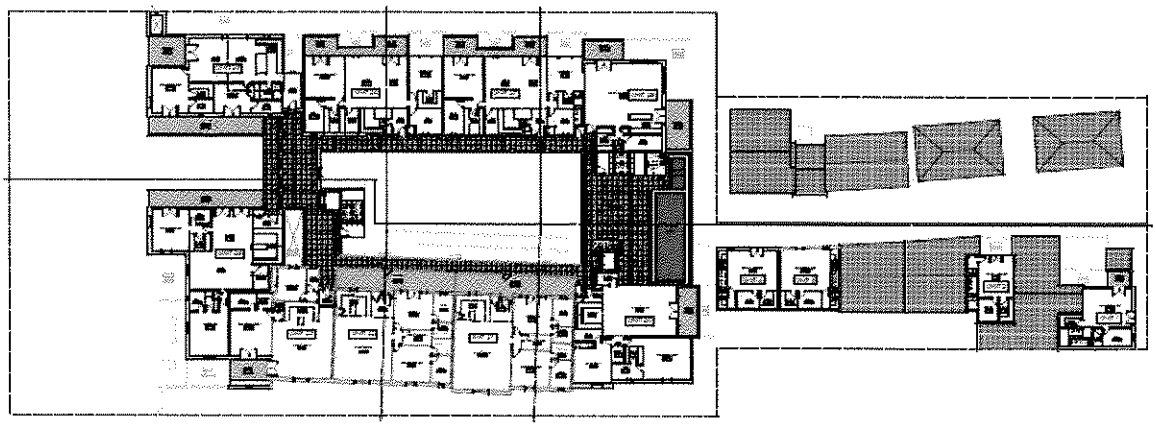

Figure 8. Third Floor Unit Plan

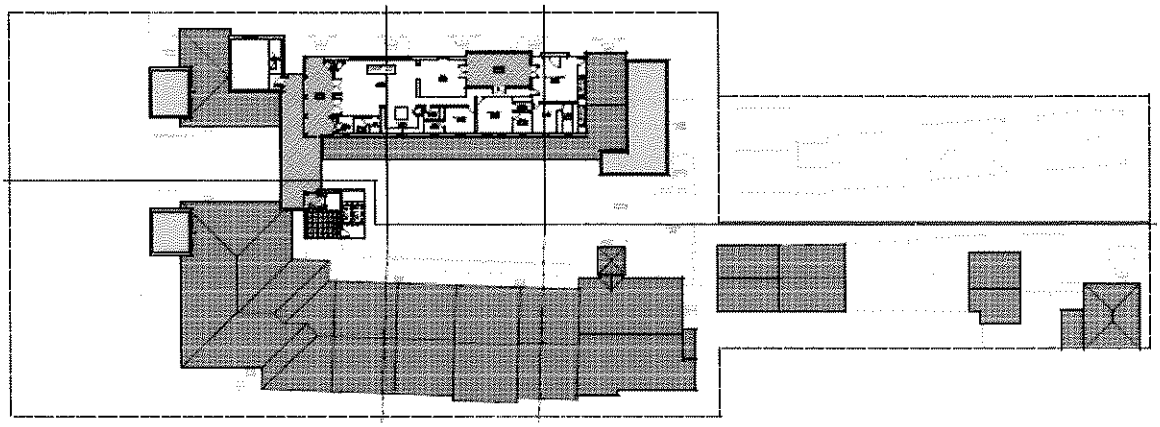

Figure 9. Fourth Floor Unit Plan

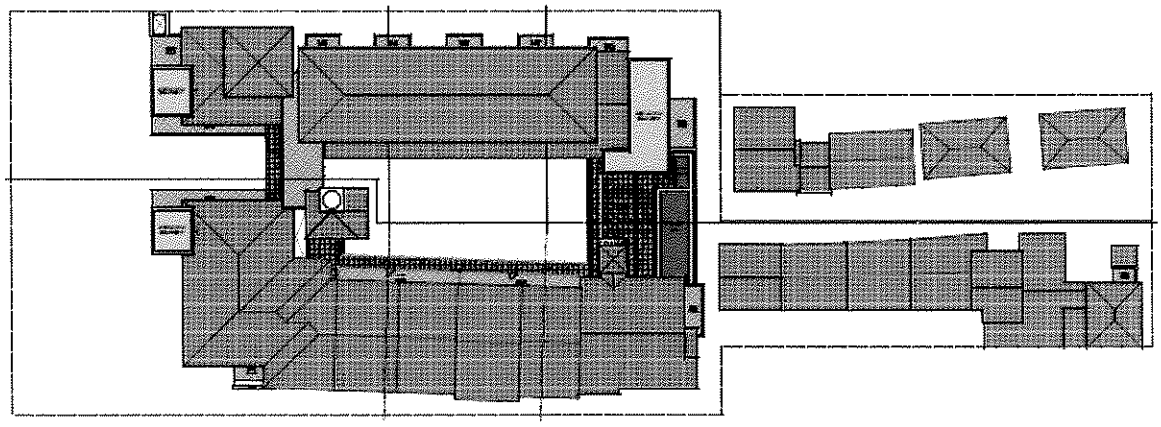

Figure 10. Roof Plan

The frequency spectrum from the rooftop noise measurement was used with a hypothetical model of a fourth floor residential unit to assess indoor noise exposure. Based on a window area of 80 square feet and a room floor area of 300 square feet, it was determined that with moderately heavy laminated glazing (PanLam 3/8" S-105), the target indoor noise criterion, 40 dB, was achieved as shown graphically in Figure 2. This is 5 dB better than required by the state and city. Using a combination dual and laminated glazing will improve this further.

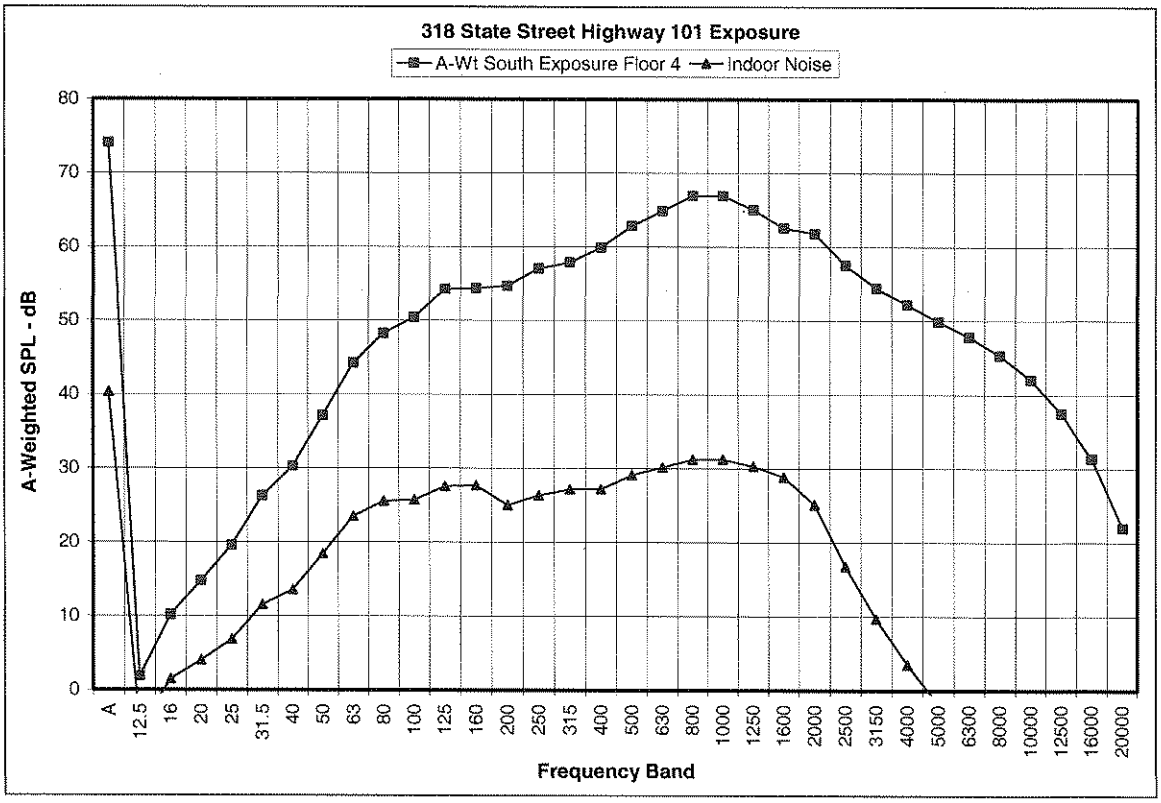

Figure 11. Full Exposure Outdoor and Indoor Noise Levels with PanLam S-105 3/8" Laminated Glazing

[Note – a unit by unit window requirement schedule will be prepared pending determination of window dimension and operability schedule].

The exterior wall construction is assumed to consist of 7/8-inch stucco, 2x6 framing, fiberglass cavity insulation and 5/8-inch type X gypsum board interior.

Ventilation and Mechanical Equipment Noise

Units with exterior exposure (see Table 2) exceeding 60 dB will require windows to be kept closed at least part of the time to exclude noise and satisfy the State and City noise standards. Ventilation systems will be required for these units. Air flow and other requirements for these systems should be determined by the Mechanical Engineer. Fresh air intakes and other exterior vents for the project should be located on the northerly side of buildings so as to be shielded from exposure to noise from Highway 101.

Unit ventilation systems should be selected based on capability to heat or cool units without producing more than 40 dB of room noise.

In addition to the unit ventilation, mechanical systems will be provided for cooling of first floor commercial spaces, ventilation of the underground garage, operation of elevators, etc. Current plans show only the potential location of this equipment, on the first floor roof at the west end of the project. Air shafts for the garage exhaust are indicated at the southwest and northwest corners of the building, venting to the atmosphere at the roof.

Outdoor living spaces and bedrooms of Units 11, 13 and 14 will be adjacent to these mechanical equipment areas. Separation walls should be of double stud construction at

these juxtapositions, and due care should be taken in the design and installation of equipment to ensure adequate vibration isolation and noise suppression. In no case should mechanical equipment be installed in contact with walls of residential units.

Plumbing

A frequently experienced problem in multi-unit residences is transmission of water flow noise by structural excitation. This issue can be avoided by:

1. Use separate plumbing risers and drain lines for every residential unit.
2. Run plumbing risers in designated chases. Avoid running plumbing in both party walls and most particularly to upper floors via interior walls of lower floor units.
3. Use compliant pipe mounts or wrap pipes with compliant material at all points of attachment with the structure.
4. Use cast iron drain piping.
5. Do not allow drain pipes to come into contact with drywall ceilings or wall surfaces.

Inter-Unit Acoustic Separation

Walls. Separation walls should not only comply with State STC 50 requirements, but also be commensurate with the quality level of the project in general. With wood frame construction, the recommended wall construction would be:

1. Double row of 2x4 studs 16" o.c. on separate plates spaced 1" apart.
2. ½" or 5/8" type X gypsum board screwed to outside face of studs on both sides of the wall
3. ½" or 5/8" type X gypsum board screwed to first layer of gypsum board on both sides of the wall
4. 3-1/2" thick fiberglass or mineral fiber insulation blanket in both stud cavities.

Owens-Corning's acoustical laboratory (OCF W-27-69) demonstrated an STC 63 rating for this assembly. In addition to high sound transmission loss, it also provides a degree of vibration isolation so that impact sounds from one unit would be suppressed in adjacent units.

To maintain acoustical integrity, penetrations for electrical boxes, etc should be offset two stud spaces on opposite sides of walls and should be caulked from the read with Lowry pads or equivalent.

Floor/Ceiling. Satisfying the State STC 50 requirement can be accomplished with a variety of design approaches. Wood joist (2x10 or 2x12, 12" or 16" o.c.) frame, ¾" plywood subfloor, 1-1/2" minimum concrete floor, 5/8" gypsum board on true RC-1 resilient channels ceiling and 3-1/2" minimum thickness sound attenuating insulation blanket in the joist cavity will more that meet this part of the criterion with a substantial margin.

However, satisfying the IIC 50 requirement and providing subjectively acceptable relief from footfall noise with this "single frame" construction is more problematical. With carpet or other "soft" flooring, the IIC 50 requirement will be satisfied easily but low frequency excitation of the floor by footfalls will often result in boomy noise downstairs. With moderately hard flooring such as vinyl and very hard flooring such as tile, the floor has high probability of falling short of IIC 50 and being subjectively unacceptable. The

IIC 50 requirement can be achieved regardless of floor covering by incorporating Enkasonic or similar compliant material within the structure of the floor.

A preferable approach if feasible on the project is to provide separate framing for floors and ceilings.

Penetrations in floors above separate units for drain lines, etc, should be enclosed and filled with insulation to prevent transmission of plumbing noises through the ceiling into the unit below.

Construction Noise

Replacement of a portion of the existing commercial uses with the proposed new mixed-use facility will involve a variety of demolition, grading and construction activities, many of which will produce noise levels in the 80+ dB range[6] at existing uses near the site. In addition, some grading and foundation installation operations could produce ground vibrations in the immediate project area. These noises and vibrations could have a significant impact, particularly on the adjacent residential units directly to the northeast, and construction should be undertaken in a manner that minimizes the degree of intrusion.

Mitigation of the Construction Noise could be accomplished by adhering to guidelines as follows:

- Restrict all construction activities to week-day daytime hours 7 a.m. – 5 p.m.
- Require that all power equipment used on the project be fitted with factory-standard noise suppression elements and that they be rated at noise level 85 dB or lower at 50 ft distance.
- Avoid use of heavy impact-producing equipment and procedures during demolition and grading/excavating.
- Alert adjacent residents of grading/excavating schedules so that if sensible ground vibration occurs, the potential for subjective alarm is minimized.

SUMMARY

The proposed mixed commercial-residential project is located at the northeast corner of Highway 101 and State Street. Due primarily to traffic on Highway 101, which is partially shielded by existing buildings between the project and the highway, exterior noise levels at the south end of the project range from approximately 50 to 77 dB. However, the project is configured so that the units' outdoor living spaces are in well shielded positions and comply with the 60 dB City outdoor noise standard. The few units with outdoor spaces partially exposed to Highway 101 can be brought into compliance with the 60 dB standard by incorporating transparent barriers at the south, east or west sides.

Indoor noise levels can be brought into compliance with City and State 45 dB standards by use of high performance windows. Actual project details will be directed toward keeping most truck noise below 40 dB for a more tranquil indoor environment.

Inter-unit acoustic separation will exceed State STC 50 and IIC 50 requirements though use of double-stud wall construction and vibration-isolating compliant floor/ceiling

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[6] *Noise from Construction Equipment and Operations, Building Equipment and Home Appliances*, EPA NTID300-1, 1971

construction. Floor elements will be incorporated that allows compliance to be maintained into the future, in case residents retrofit hard flooring materials.

Noise from plumbing will be controlled by judicious pipe routing, compliant pipe mounting and use of iron drain pipes. Mechanical systems as required for ventilation of units with closed windows will be designed for quiet operation and will have air intakes located on the shielded sides of buildings.

Mechanical systems serving commercial and common project areas are located adjacent to residential units and must be designed and installed in such a manner as to avoid noise intrusion.

Project construction noise impacts will be mitigated by restriction to daytime working hours and exercising due diligence in selection and operation of equipment.